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Planning bicycle infrastructure based on quickest route method

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PLANNING BICYCLE INFRASTRUCTURE BASED ON THE QUICKEST OR EASIEST ROUTE METHOD

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Purpose of the Research: To develop a model for bicycle infrastructure planning that allows choosing the quickest route considering that speed varies according to human physical abilities.

Objectives:

- Identify the criteria that have the most significant influence on bicycling travel time.
- Develop a model of estimating travel time that accounts for maximum power available to the rider
- Solve bicycle route choice problem to minimize travel time
- Propose location of bicycle ways based on fastest routes

Findings from Literature

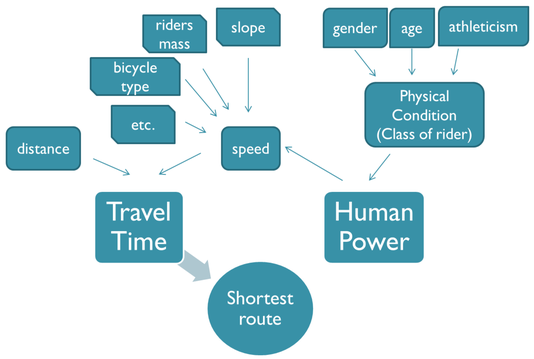
- Safety is an important concern for all types of riders
- Time is the most important factor for utilitarian cyclists
- Bicyclists ride faster if they feel safe on the road
- A commuter cyclist would rather cycle 1.76 miles on a flat route than bicycling one mile on an uphill slope of 2-4 percent
- Women prefer flat or moderate terrain while men prefer moderate to steep slopes
- Speed varies significantly based on the topography

Lack of existing methods:

Infrastructure planning framework does not consider travel time along the routes proposed. Current bicycle models assume average speed along the route and among routes and travel time is proportional to distance traveled. There is no method that determines the realistic cycling travel time based on change in speed due to topography.

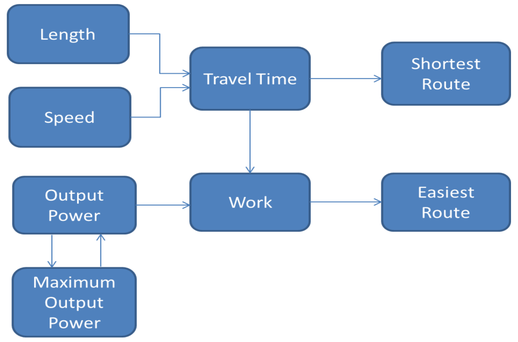
1 Identify the criteria that have the most significant influence on bicycling travel time

Factors that affect bicycling travel time



2 Develop a model of estimating travel time that accounts for maximum power available to a rider

Conceptual Model of Route Choice



Speed—Power Relationship

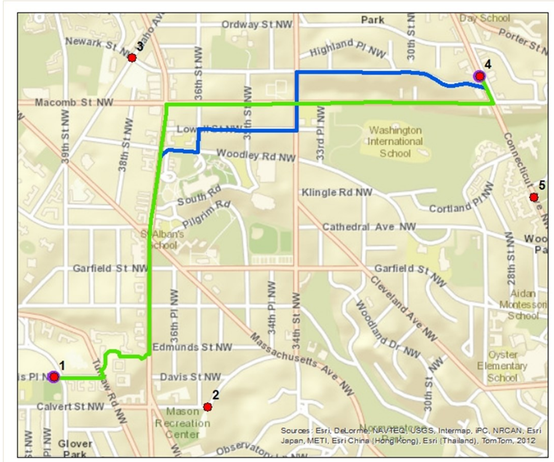
$$V = \left(\frac{W_{max}}{K_A V^2 + mg(s + C_R)} + K_C V\right) \cdot \frac{1}{K_C + 1}$$

Model Parameters

Aerodynamic-drag factor (K_A), kg/m	0.3871
Riding velocity (V), m/s	6
Mass (m) , kg	95
Acceleration due to gravity (g), m/s^2	9.81
Slope (s)	varies
Coefficient of rolling resistance (C_R)	0.003
Maximum power output (W_{max}), W	200
Convergence parameter (K_c)	0.5

3 Solve bicycle route choice problem to minimize travel time

Two scenarios of Route Travel Time



Scenario 1—Travel time calculated based on constant speed

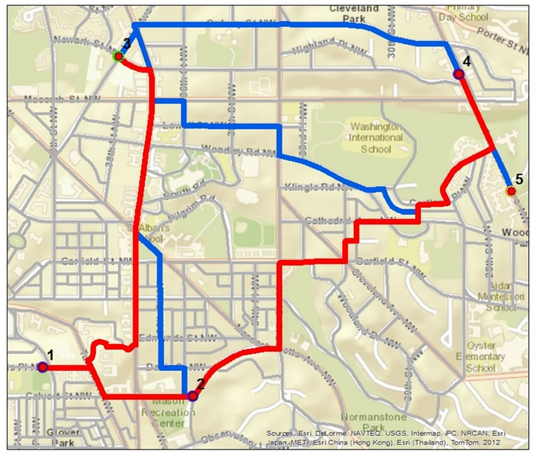
Scenario 2—Travel time calculated based on Power Model

Route Characteristics

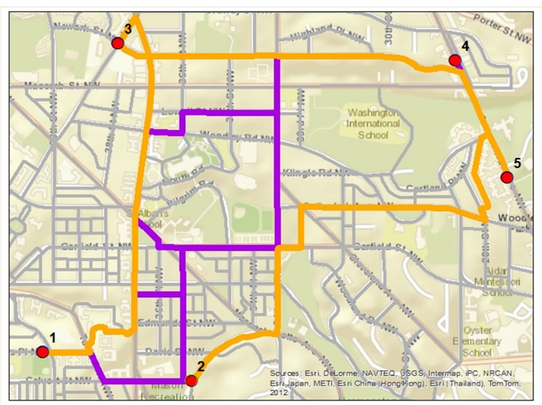
Route	Total Travel Time, min	Total Length, m	Total Length, mi	Physical Work, 0.6 J
Scenario 1	11	2934	1.82	1820
Scenario 2	10	3000	1.86	1460

4 Prioritize bikeways location

quickest route method



easiest route method



Key Results

- Developed a model to estimate bicycling speed based on relationship between human power and road topography
- Model allows to predict realistic bicycling travel time
- Optimal route can be solved with time (quickest) or work (easiest) impedance

Application to Practice

- To calculate time for travel forecasting models;
- To estimate time for integrating transit and cycling;
- To prioritize bikeway infrastructure;
- To evaluate the levels of difficulty for different routes;
- Can be integrated into personalized route planning software

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